EG&G Idaho, Inc.

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INTERNAL TECHNICAL REPORT

Title: CHARACTERIZATION OF THE RALA OFF-GAS CELL, CPP-631

Organization:

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1. INTRODUCTION

The Waste Programs Division of EG&G Idaho, Inc., and Exxon Nuclear Idaho Company (ENICO) have completed a physical and radiological characterization of Radioactive Lanthanum-140 (RALA) Off-Gas Cell, CPP-631, located at the Idaho Chemical Processing Plant (ICPP). This work was performed in anticipation of possible facility decontamination and decommissioning (D&D).

This report describes the original RALA off-gas system as well as the existing system, with special emphasis on CPP-631 and its contents. Surface and internal radiation fields, contamination, and radionuclides present are reported.

In addition, an estimate of the weight and volume of the contaminated waste is given.

2. ICPP RALA OFF-GAS SYSTEM BACKGROUND AND HISTORY[a]

The RALA off-gas system was designed and installed to handle the gases generated during the operation of the RALA process system located in L-cell of the process building, CPP-601.

The term RALA is an abbreviation for Radioactive Lanthanum-140 which is the decay product of barium-140. The RALA system was designed and built to separate barium-140 from short-cooled MTR fuel. Short-cooled fuel is spent fuel which has had little time to decay, and consequently fission products in the fuel include the short-lived isotopes. The start-up operation ran from November 1955 to June 1957. The RALA process campaign ran from 1957 to 1963. During this campaign, over a million curies of radiobarium were recovered.

RALA off-gas processing involved two problems: (1) activity hazard due to active iodine and xenon, and (2) explosion hazard due to contained hydrogen. The off-gas radioactivity was too high to permit indiscriminate venting to the atmosphere, and the hydrogen concentration was in the explosive region making mechanical compression and storage hazardous.

A caustic scrubber (L-102) was the only equipment originally installed in L-cell for processing radioactive gas. The architect-engineer assumed that any active gases passing through the scrubber could either be briefly stored for decay or could be vented directly to the stack under favorable weather conditions. However, there was no equipment available for storage of this gas in the anticipated volume and composition. Consequently, operation was necessarily limited to periods when the weather was favorable for stack disposal.

In order to make the RALA processing weather-independent, a 10,000-ft^3 tank was installed to hold xenon and iodine gas until weather

a. B. M. Legler et al., Startup Operation of a Production Facility for Separating Barium-140 from MTR Fuel, IDO-14414, September 1, 1957.

permitted their release. The tank was installed in July 1957, just after completion of the start-up program. During the start-up program, however, it became obvious that the gas holder then being installed would not be the final solution to the RALA off-gas problem. This was due to iodine being released over a period of days rather than minutes or hours and also due to radioiodine escaping from centrifuges to cell off-gas which did not pass through the scrubber. However, the holding tank was still useful because it could contain process off-gas from 10 hours of operation. Thus it could hold radioactive xenon until favorable weather conditions allowed venting to the atmosphere. Also, the tank was large enough so that hydrogen could be diluted below its lower explosive limit.

The final solution to the off-gas problem was the installation of a separate RALA off-gas system. This new system included the 10,000-ft^3 gas holding tank, a blower and two jets for providing necessary vacuum venting, and necessary valving and controls. The new off-gas system also included carbon beds for iodine removal. In this report this final RALA off-gas system is referred to as the original system.

3. RALA OFF-GAS SYSTEM DESCRIPTION

3.1 Original RALA Off-Gas System

A simplified flow diagram of the original RALA off-gas system is shown in Figure 1. Most of the system components are contained in the RALA Off-Gas Cell, CPP-631. This cell is an underground structure approximately 10 ft by 14 ft by 9 ft high constructed in the earth embankment outside the southeast corner of process building, CPP-601. The entrance to the cell is shown in Figure 2. A cut-away artist's drawing showing the major components in the cell is shown in Figure 3. The cell is constructed out of reinforced concrete and contains a centrifugal blower, gaseous nitrogen operated ejectors to evacuate the off-gas from a reaction vessel inside the process building, remote control valving, two carbon beds enclosed by lead shielding walls, two filters, and a hydrogen analyzer. CPP-631 is provided with utility connections, ventilation, heating, and instrumentation necessary for equipment operation. All piping between CPP-601 and CPP-631 runs through an underground concrete tunnel. This tunnel is approximately 2 ft square and contains a ventilation duct into the vent corridor of CPP-601 as well as the piping. This ventilation duct ensures a negative pressure inside CPP-631.

Another pipe tunnel enclosed the piping between CPP-631 and the valve box CPP-726. The valve box, CPP-726 is located underground at the foot of the waste gas stack. Also, a pair of underground lines connected the valve box with the gas storage tank, CPP-727, and another line ran from the valve box to the stack, CPP-708. The gas storage tank sat above ground.

3.2 Existing RALA Off-Gas System

Most of the original RALA off-gas system remains intact today. A few components have been removed, and these are discussed in this section. The existing system is contained in the RALA Off-Gas Cell and the pipe tunnels.

Photographs taken in 1981 of the interior of CPP-631 are shown in Figures 4 through 15. The system components are described in Table 1.

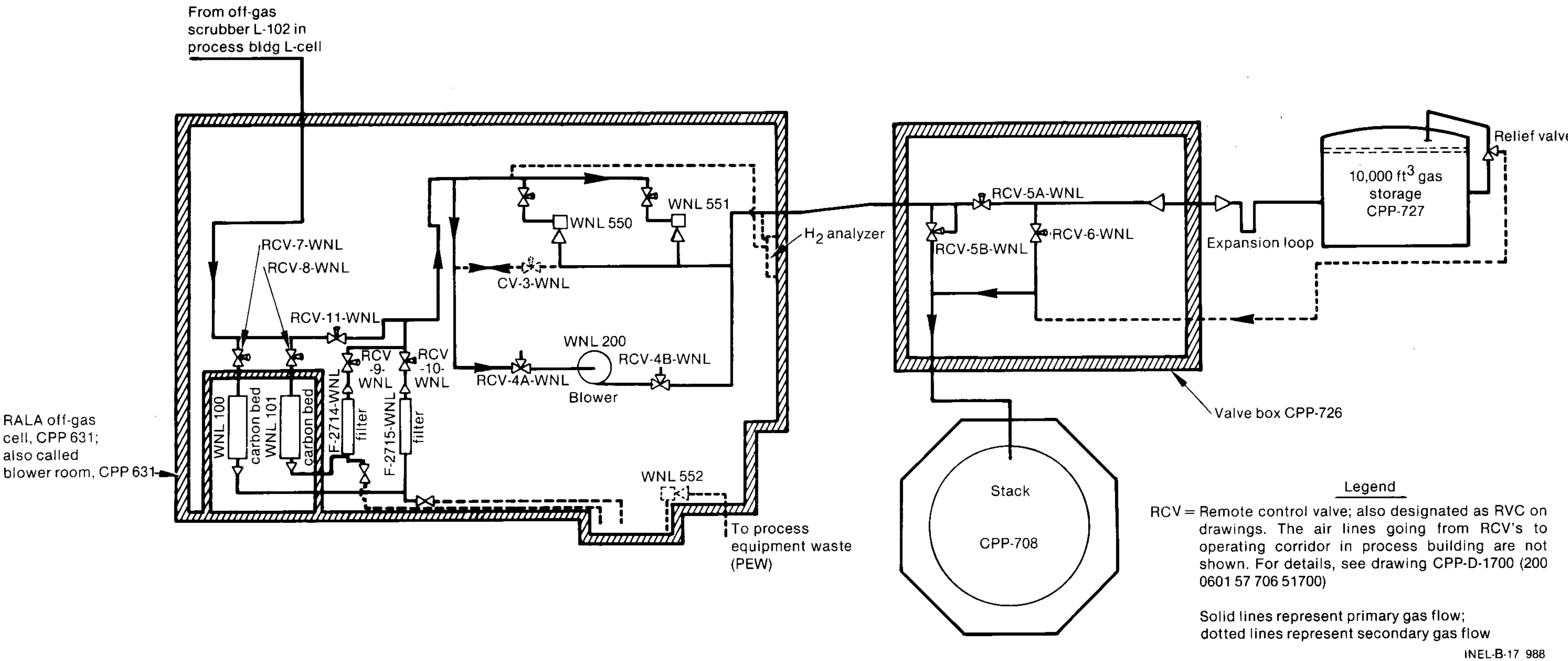

Figure 1. Simplified RALA off-gas flow diagram of original system.

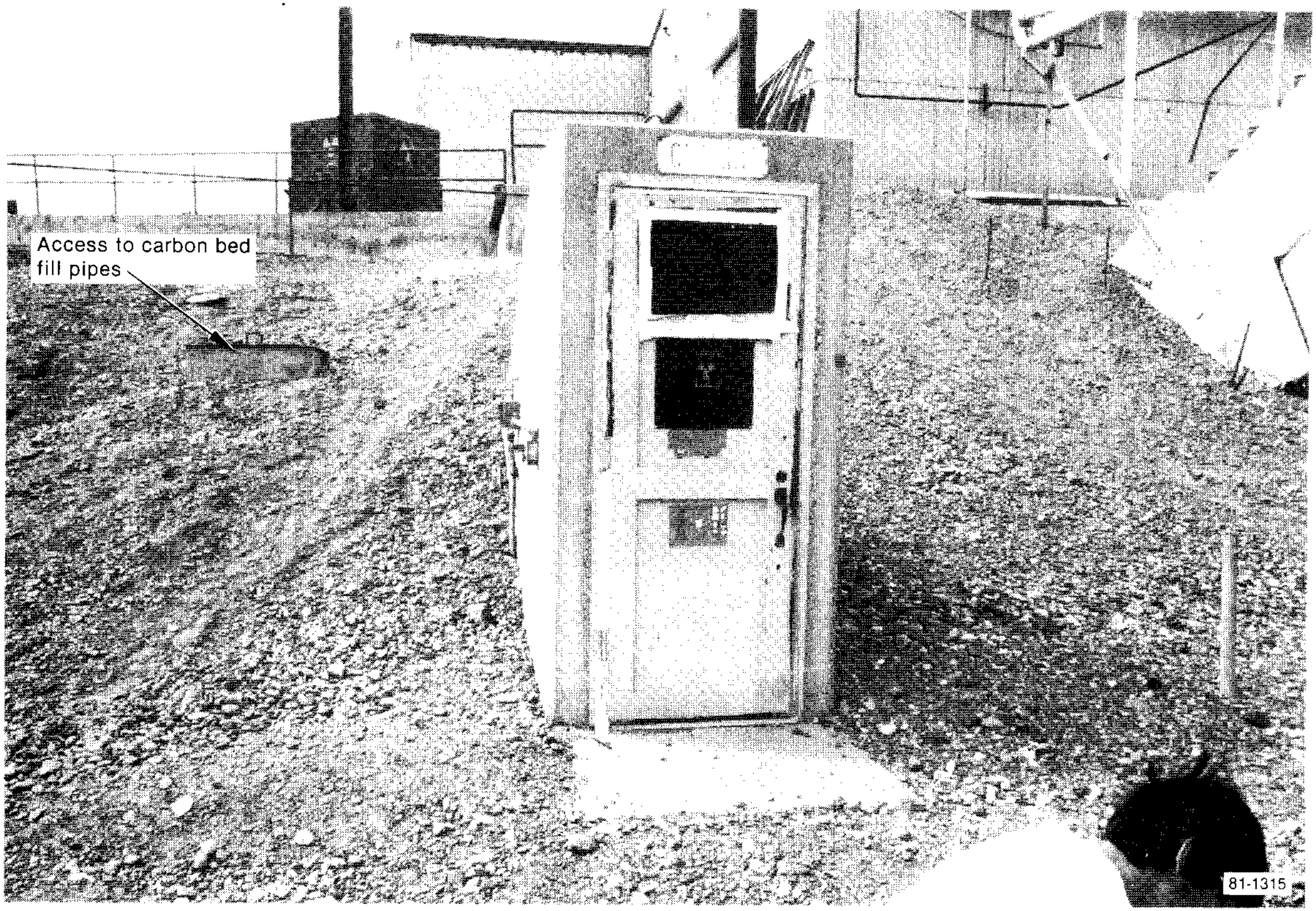

Figure 2. Entrance to the RALA off-gas cell, CPP-631.

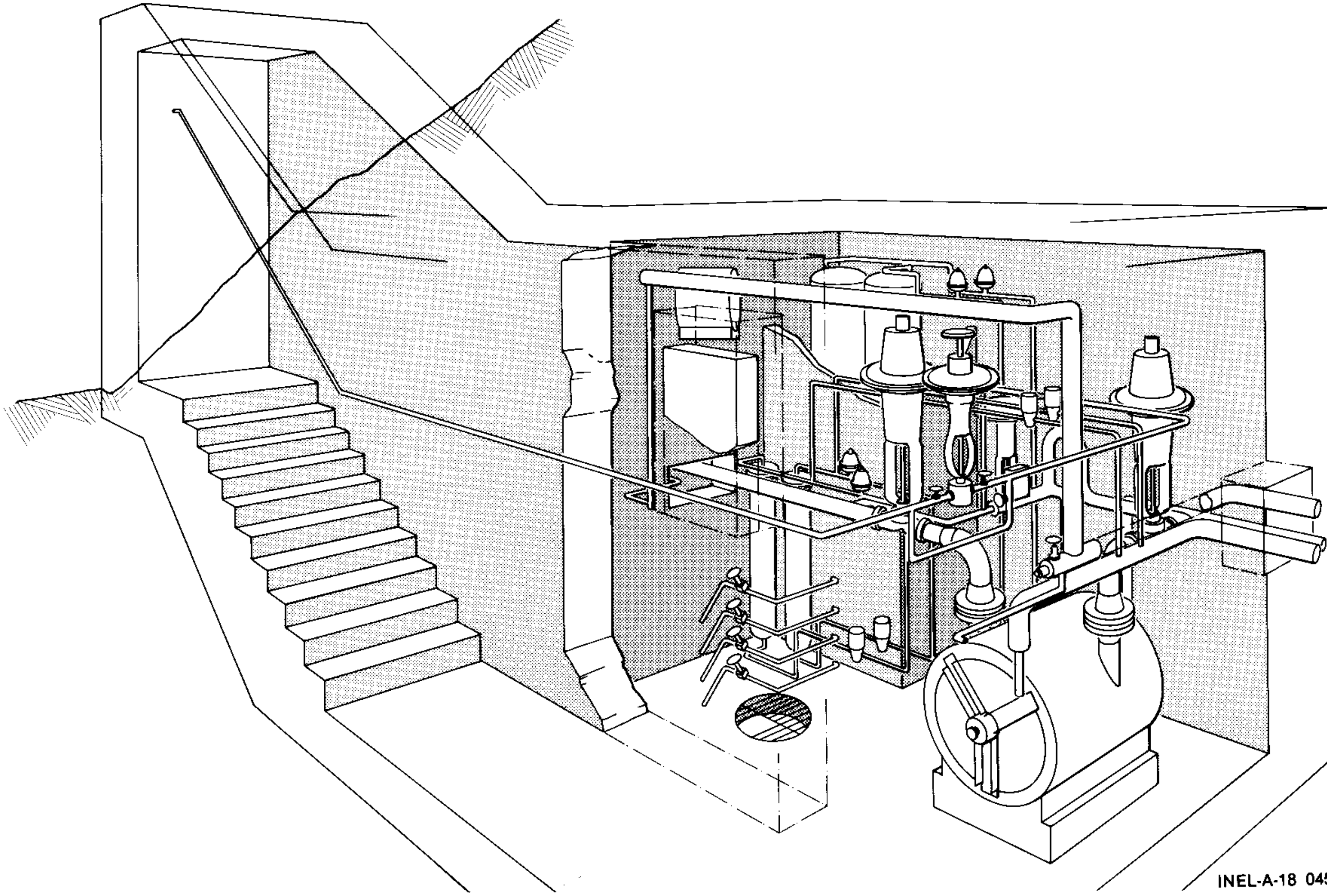

Figure 3. RALA off-gas cell, CPP-631.

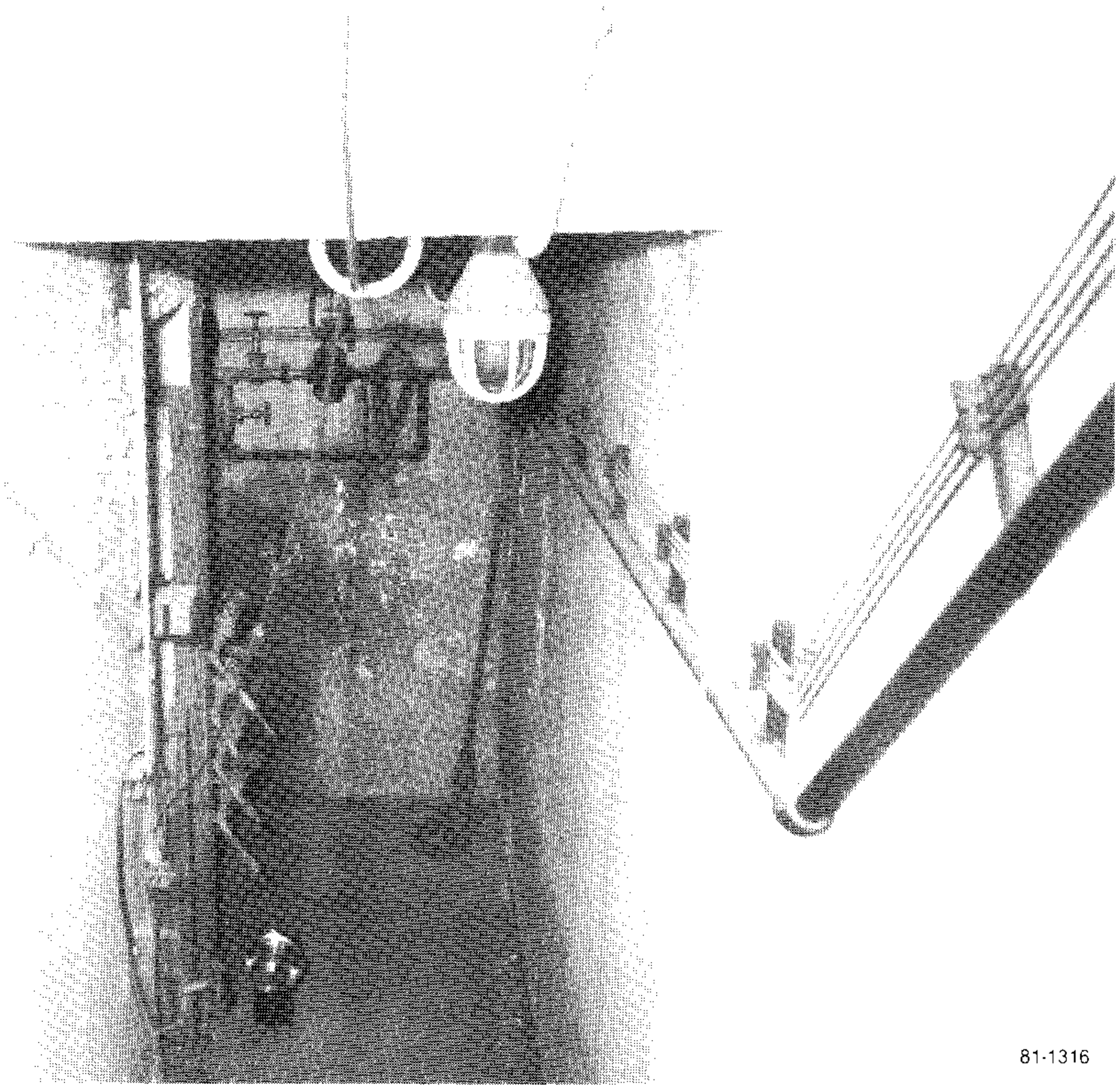

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Figure 4. Entry way into CPP-631 looking down steps.

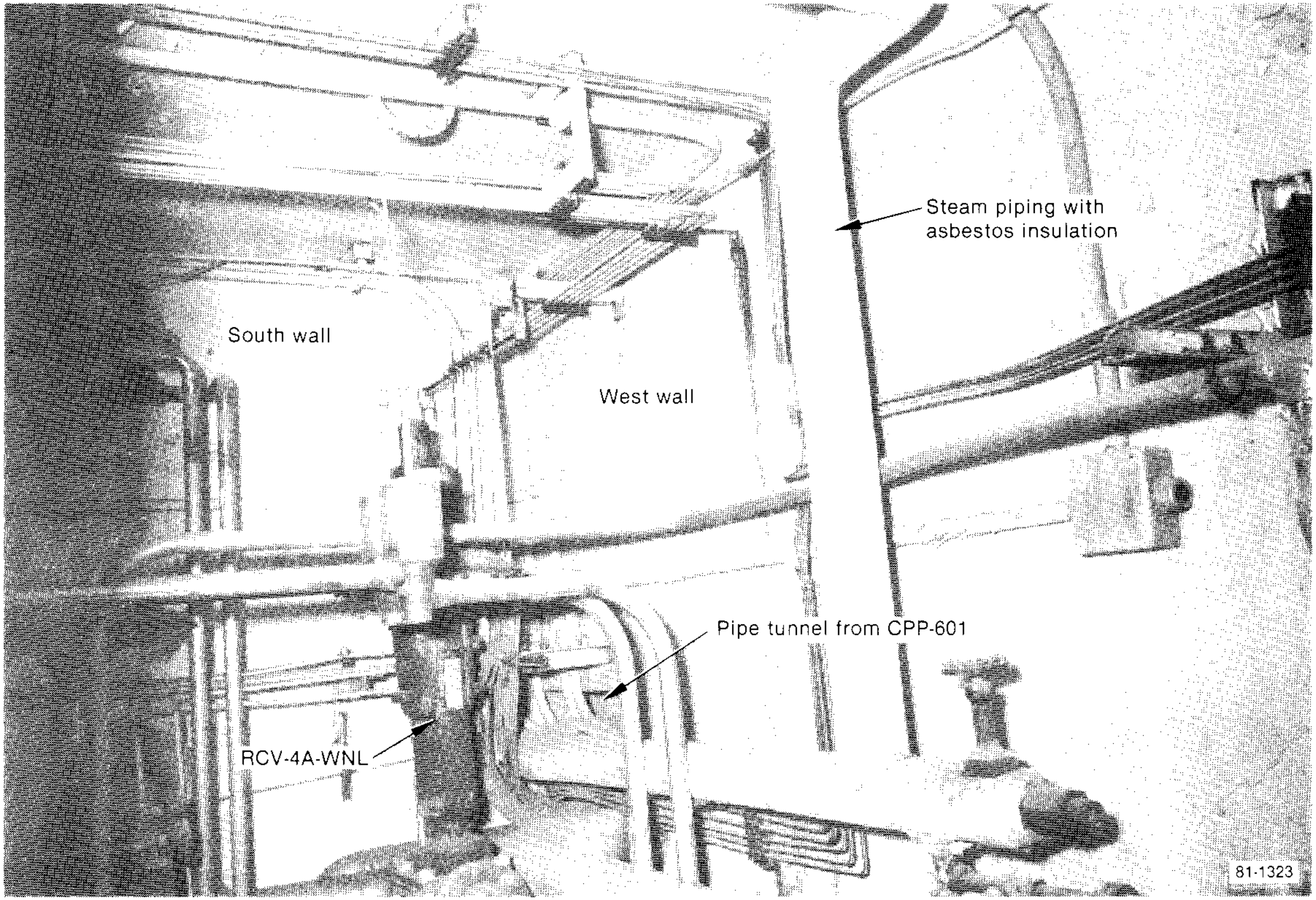


Figure 5. RALA cell looking into southwest corner.

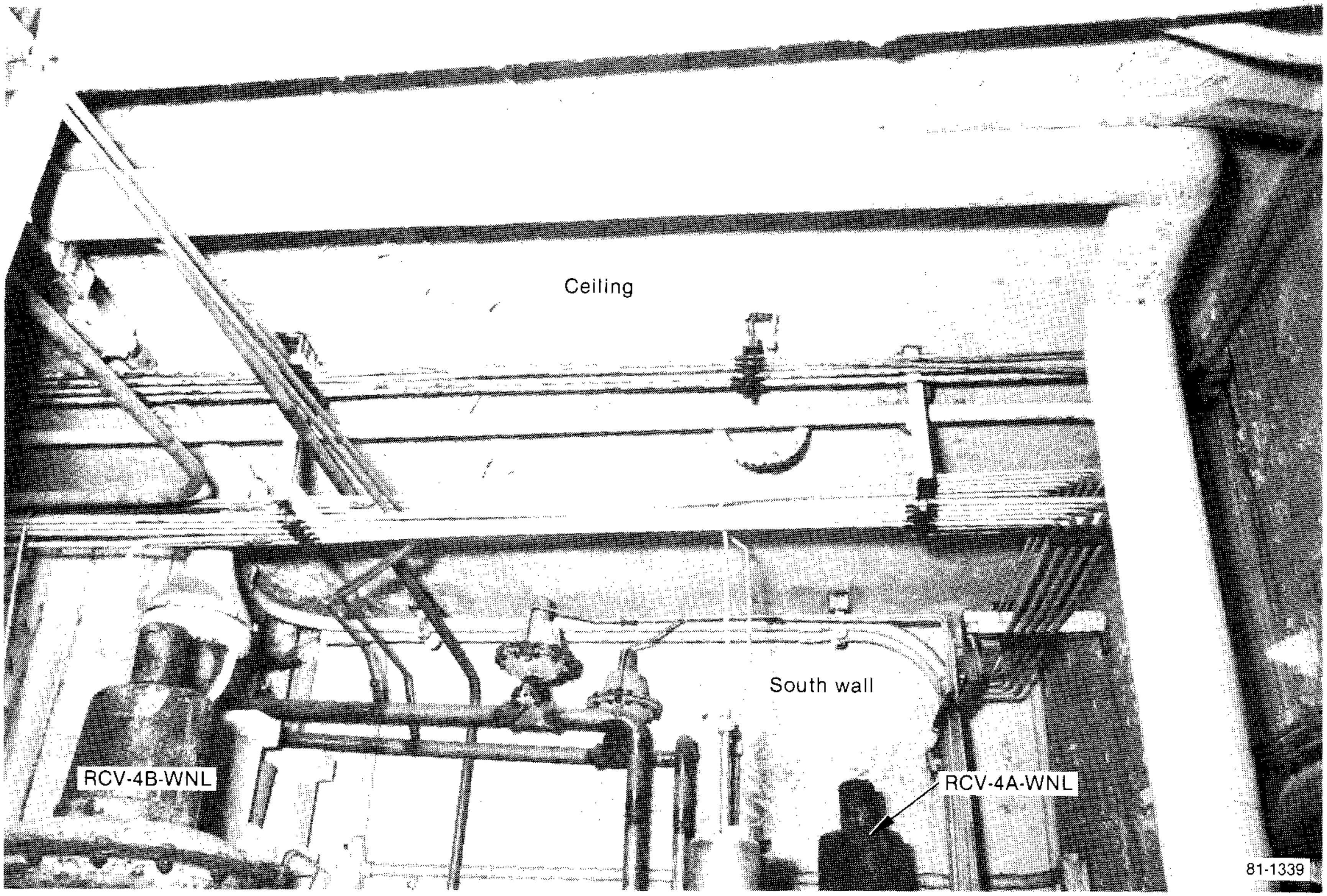


Figure 6. RALA cell looking toward upper south wall.

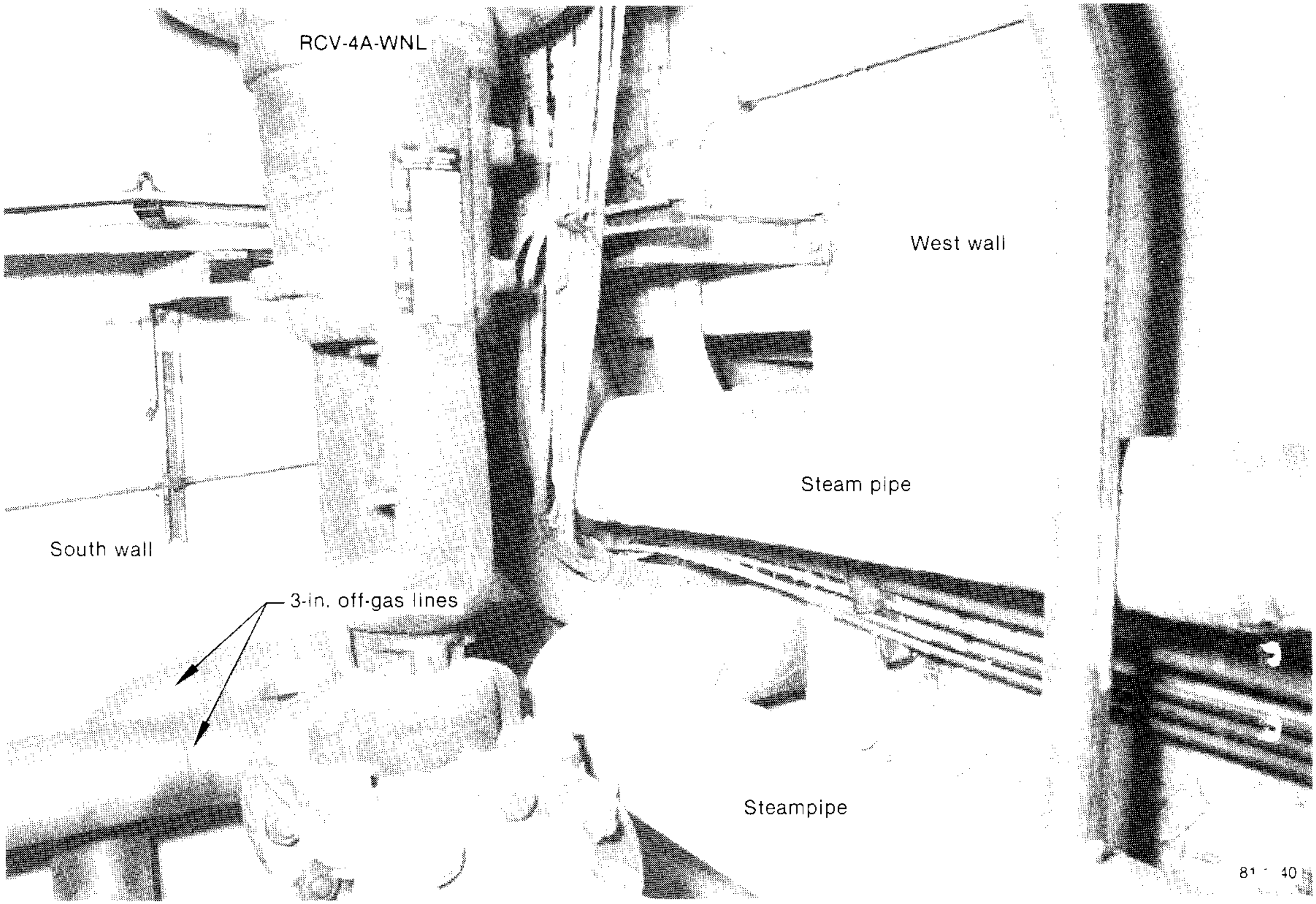


Figure 7. RALA cell showing close-up of input pipe tunnel from CPP-601.

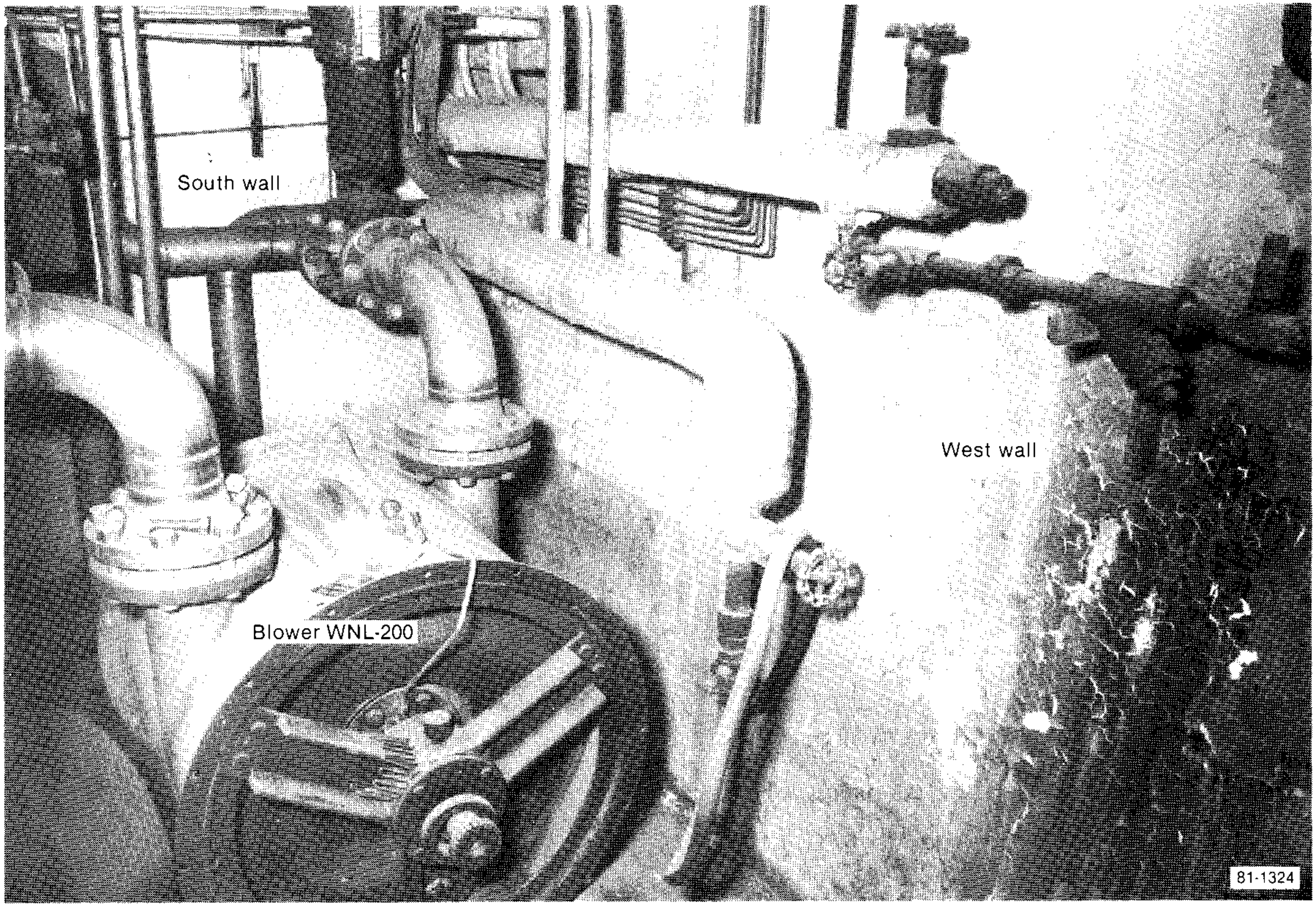


Figure 8. RALA cell looking into lower southwest corner.

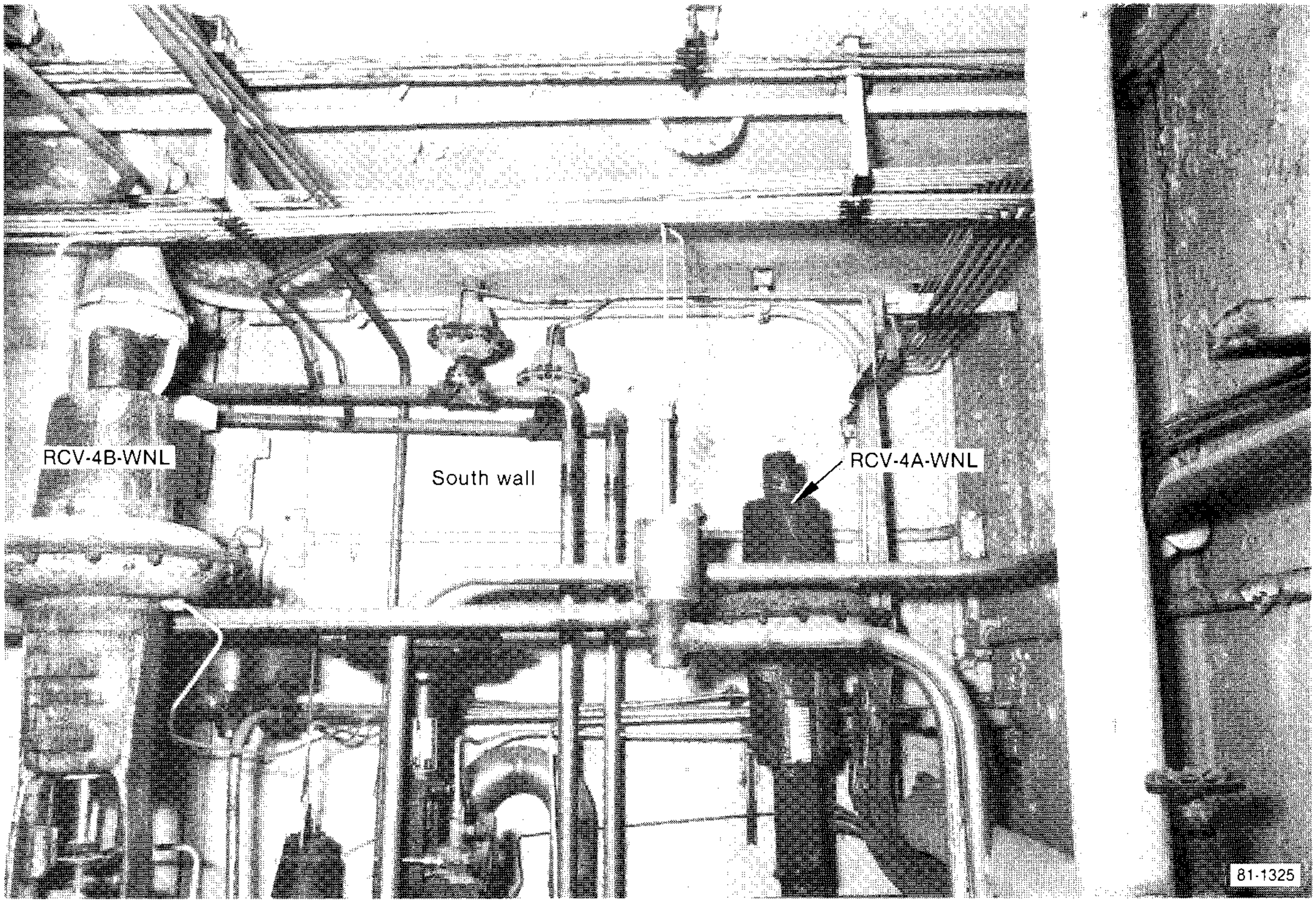


Figure 9. RALA cell looking toward south wall.

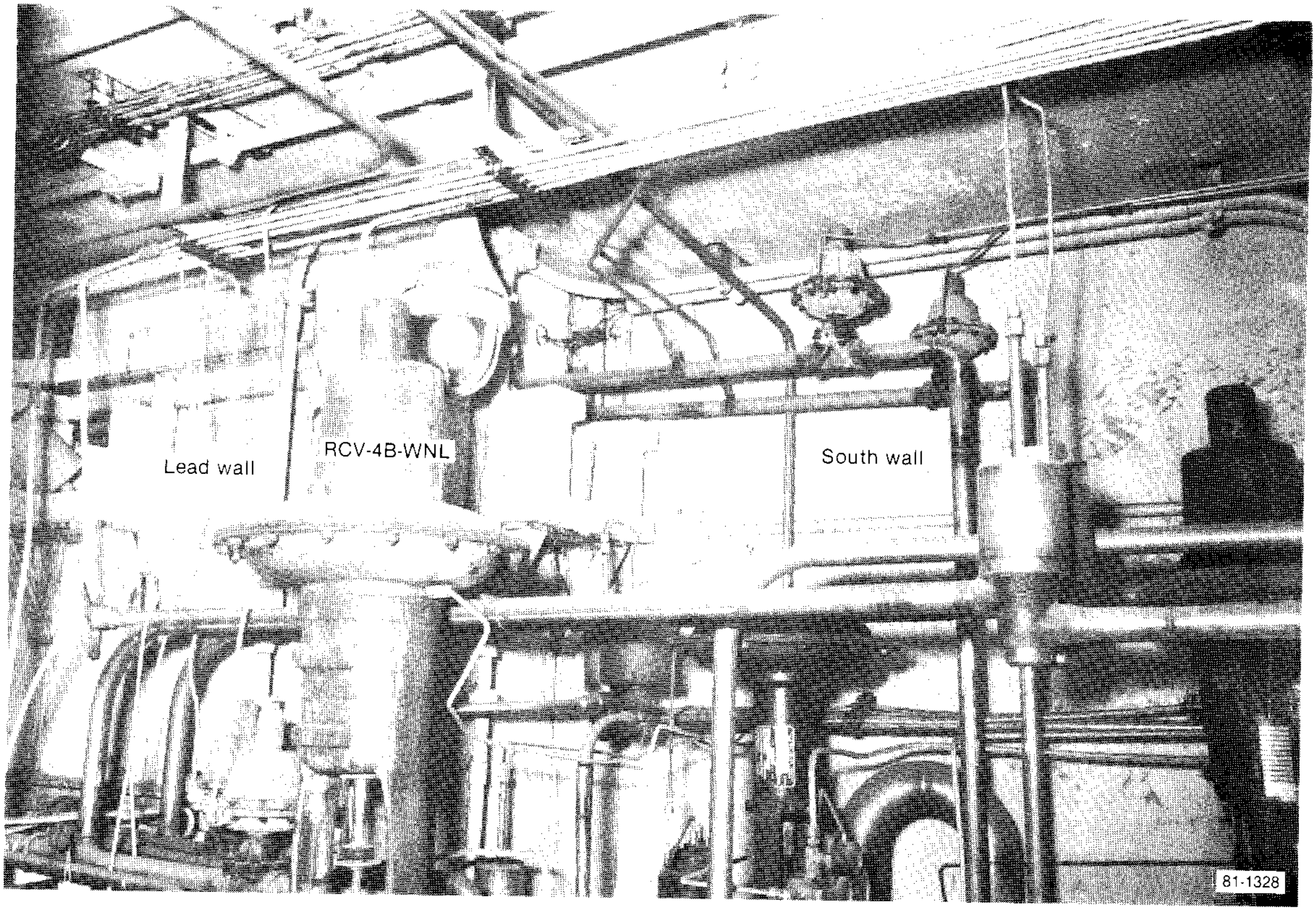


Figure 10. RALA cell looking toward upper southeast corner.

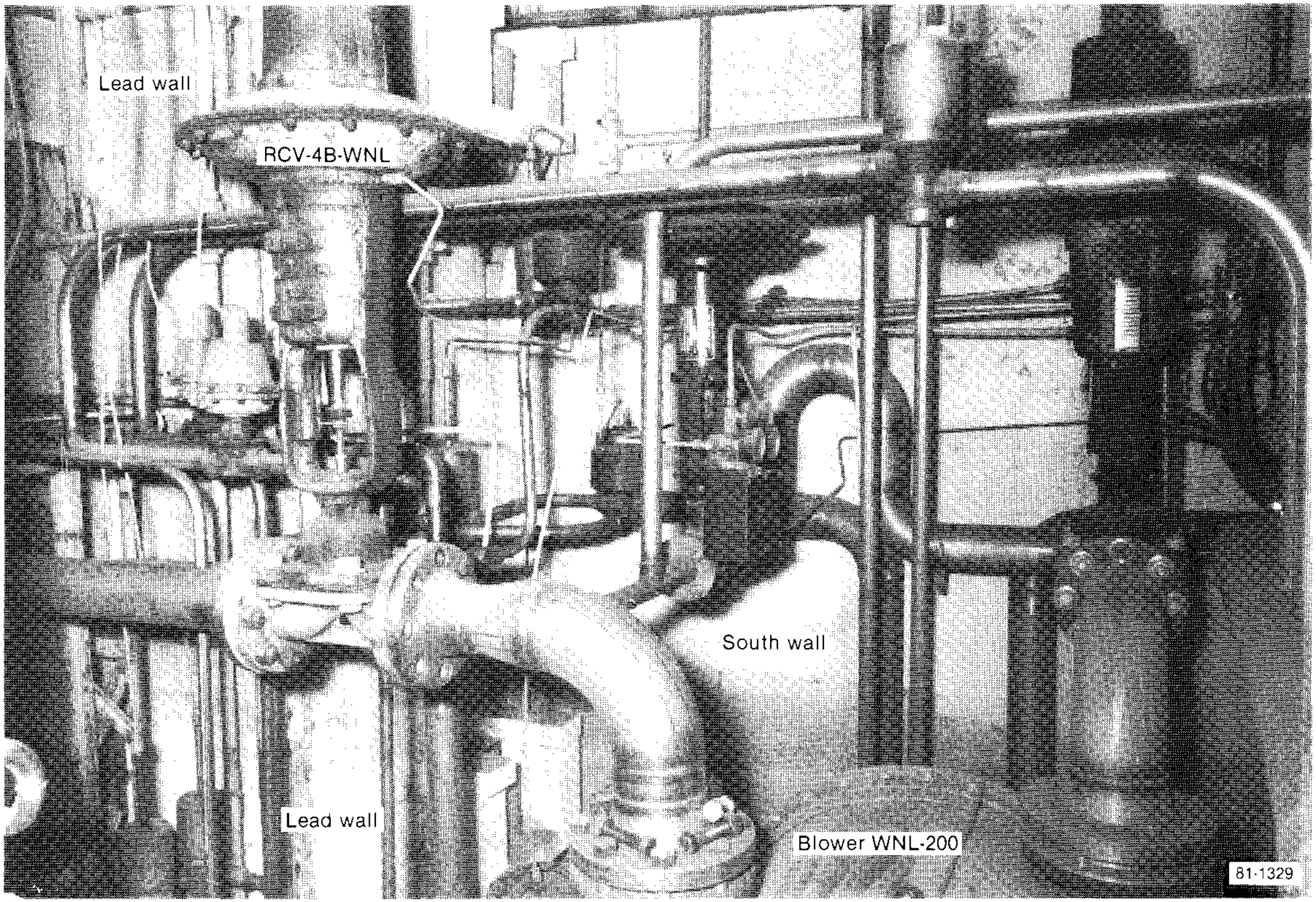


Figure 11. RALA cell looking toward center southeast corner.

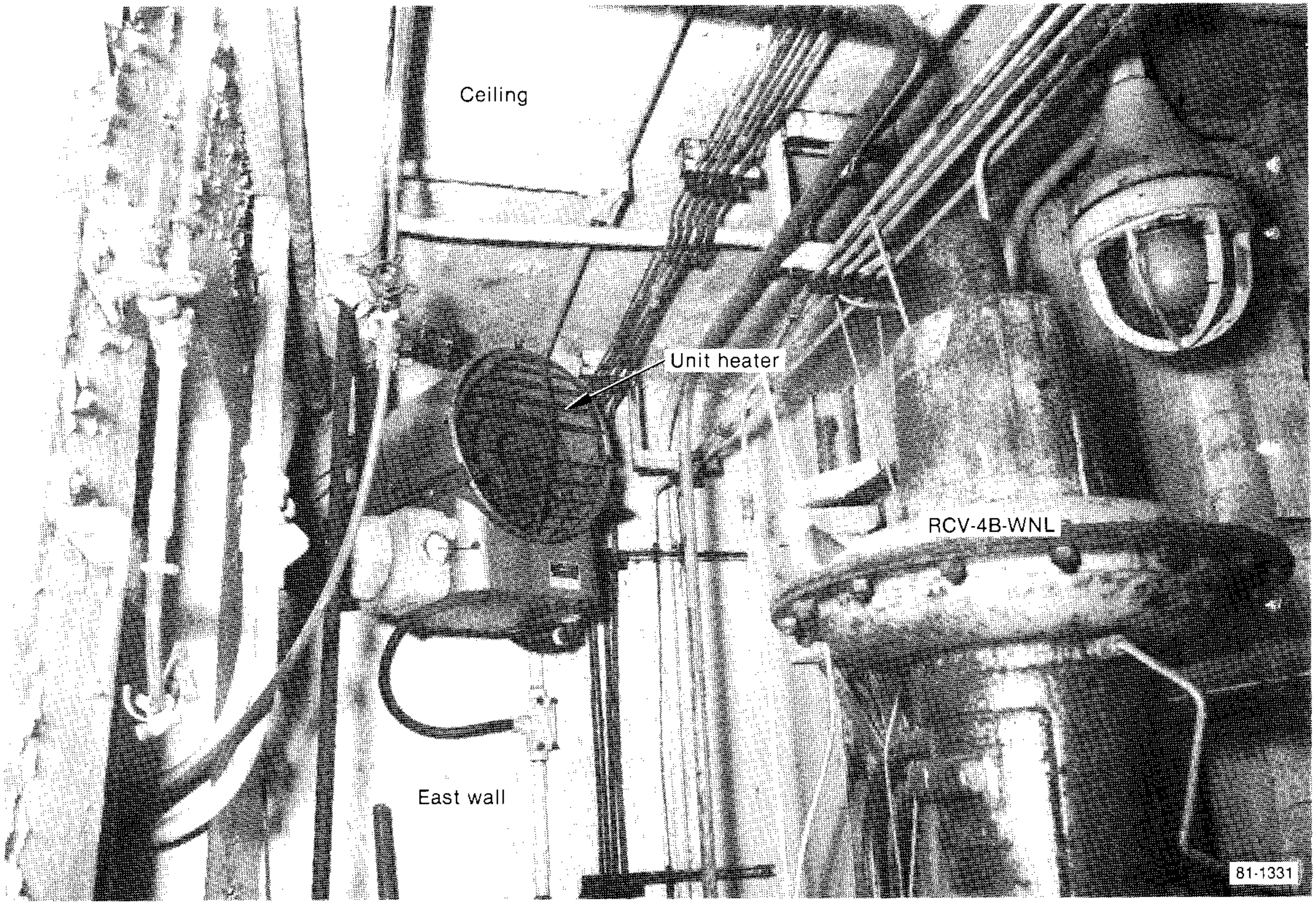


Figure 12. RALA cell looking toward upper east wall.

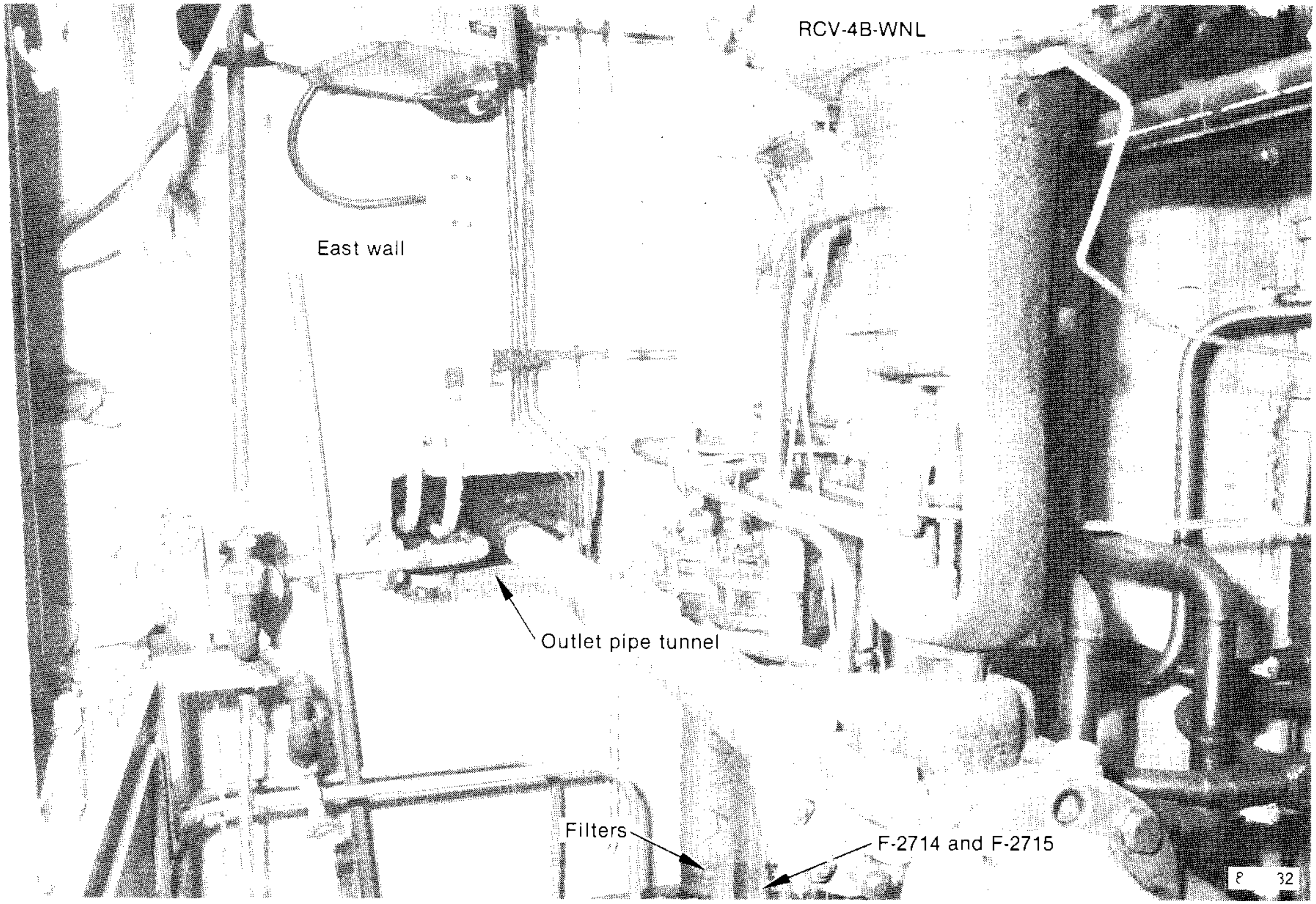


Figure 13. RALA cell looking toward center east wall.

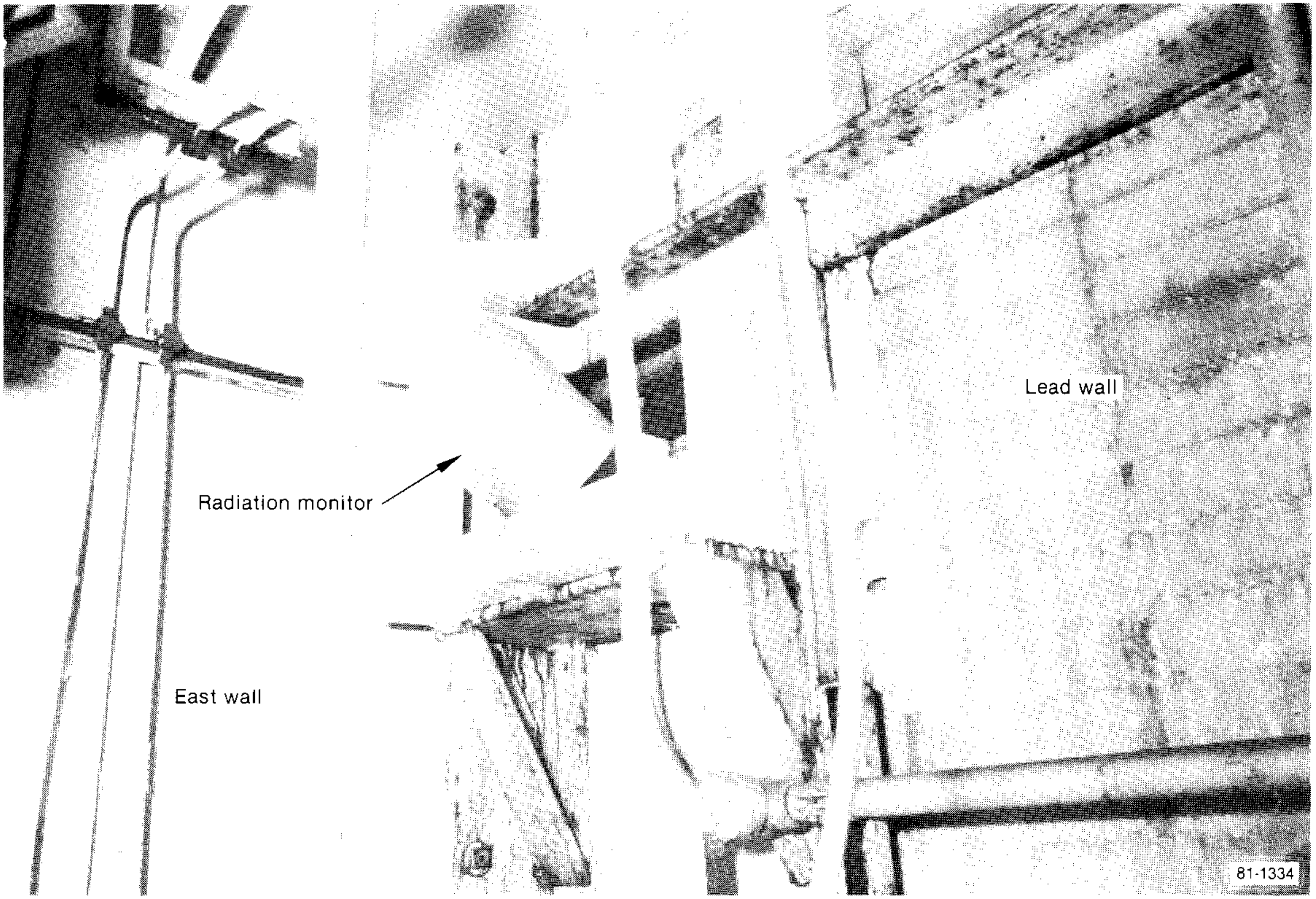


Figure 14. RALA cell showing lead shielding wall with radiation monitor.

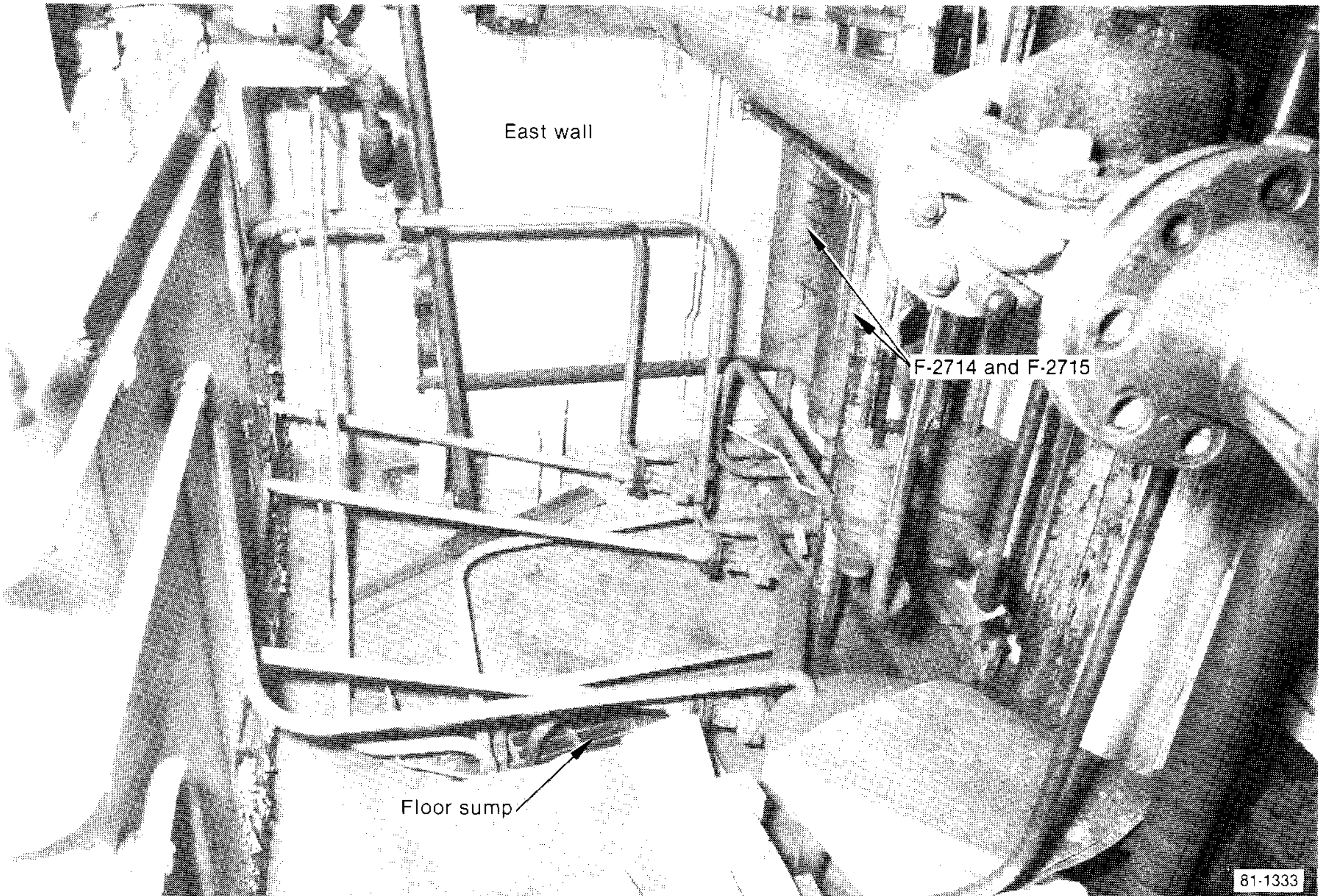


Figure 15. RALA cell looking toward lower east wall.

TABLE 1. DESCRIPTION OF RALA OFF-GAS EQUIPMENT

Equipment	Description
WNL-200 RALA off-gas blower	Turbine blower without motor; 27 in. diameter circular blower housing with a total volume of 13 ft^3 and a weight of 300 lb; 347 SS construction
WNL-100/101 RALA off-gas carbon bed vessels	Cylindrical with dished heads, 16 in. OD and 79 in. tall with a total volume of 7 ft^3; weight of 800 lb fully charged, and a bed weight of 100 lb; supported by three 14-in. legs; 3 ft long by 3 in. OD fill pipes extending through ceiling
WNL-F-2714/2715 RALA off-gas filter case	Cylindrical with flanged top head; 4 in. OD by 27 in. tall; total volume of 0.2 ft^3 and a weight of 30 lb; removable filter element in place
Hydrogen analyzer	Lead cabinet containing thermal conductive metal block; dimension of 1 x 1.5 x 2 ft; 316 SS construction
WNL-550/551 Transfer jets	L-cell DOG jet operated by steam, air, or nitrogen
WNL-552 Transfer jet	RALA off-gas cell floor sump jet to WL-102, operated by steam; 316 SS construction
RCV-4-WNL-A/B, RVC-11-WNL Valves	3-in. off-gas blower remote control valves; air operated; 316 SS construction
RCV-1 through 3/7 through 18-WNL Valves	Off-gas remote control valves; 1/2 in. to 3/4 in.; air operated; 316 SS construction
Unit heater	Steam operated heater for heating cell
Radiation monitors	Remote radiation detectors for monitoring carbon bed; four detectors located on lead shielding wall

All remote controls associated with the RALA off-gas system such as valves, instrumentation, and utilities were removed in December 1980 during decommissioning of L-cell out-of-cell equipment in CPP-601.

The pipe tunnel and piping between buildings CPP-631 and CPP-601 is in its original configuration. The pipe tunnel and piping between CPP-631 and CPP-726 (Figure 1) have been removed except for approximately 75 ft near CPP-631. The piping and valves associated with RALA off-gas in CPP-726 have been removed. The piping which ran between CPP-726 and CPP-727 was removed as well as CPP-727, the 10,000 ft^3 gas storage tank. This tank is now isolated at a location near the south end of the ICPP. The characterization of the gas storage tank is not included in this report.

Two carbon beds (WNL-100 and WNL-101) are enclosed by two lead shielding walls in the southeast corner of CPP-631 (Figure 3). The walls are fabricated from curved lead bricks to eliminate line-of-sight between bricks. The bricks are supported by carbon steel support structures. Limited access to the inside of the lead shielding walls can be attained through four 1-in. holes used for monitoring carbon bed radioactivity. Four radiation monitors are presently located at these holes. One monitor is shown in Figure 14. Each carbon bed was equipped with a 3-in. stainless steel pipe which ran to the surface above CPP-631 (Figure 2). These pipes allowed access to each carbon bed for emptying and recharging the carbon.

4. CHARACTERIZATION PERFORMED AND RESULTS

4.1 Radiation Survey

The radiation fields were measured using a Ludlum 14C GM meter. Measurements were made on the interior walls and floors. In addition, radiation fields inside the shielded southeast corner were measured using the existing instrument penetrations discussed in Subsection 3.2. Measurements of the field inside the carbon beds were made by lowering a probe through the 3-in. pipe accessing each carbon bed from the surface above the cell. The fields inside off-gas piping were made by removing flanged sections of the pipe.

The results of the external radiation survey are shown in Figure 16. The radiation fields inside off-gas piping are shown in Figure 17.

4.2 Contamination Survey

Smears were taken at randomly selected spots inside the cell. These smears were counted in order to get a contamination measurement in disintegrations per minute (dpm). The smears were also later analyzed for isotopic content and concentration. The location, assigned sample number, and contamination of each smear are shown in Figure 18. Smears were also taken from internal surfaces of piping. These smears were also counted for contamination and later analyzed for isotopic content and concentration. The location, assigned sample number, and contamination level in dpm (β) are shown in Figure 19.

4.3 Radioisotopic Analysis

The smears taken to determine surface contamination were later dissolved and analyzed at the ICPP radiochemistry laboratory to determine isotopic content and concentration. The results of this analysis are shown in Table 2. The location and number of each sample in Table 2 corresponds to the smear number designated in Figures 18 and 19.

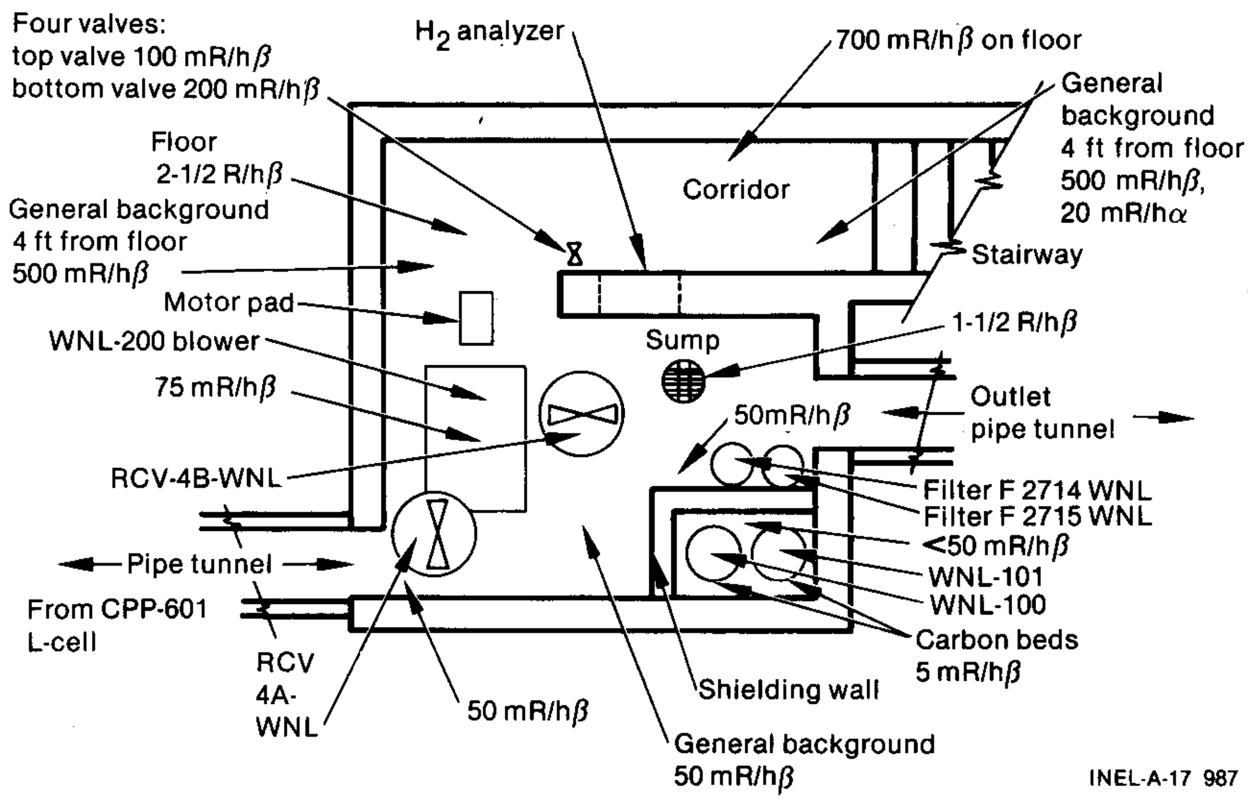


Figure 16. Radiation fields inside CPP-631.

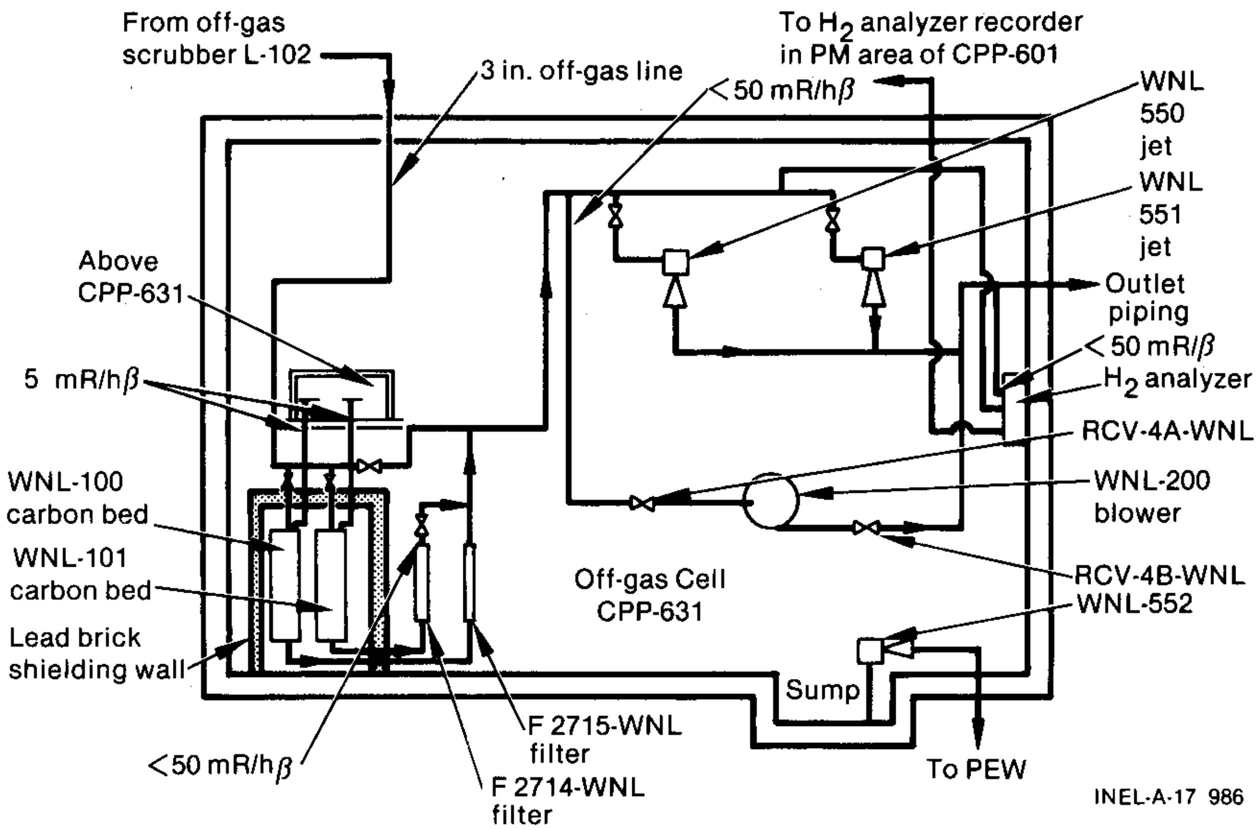
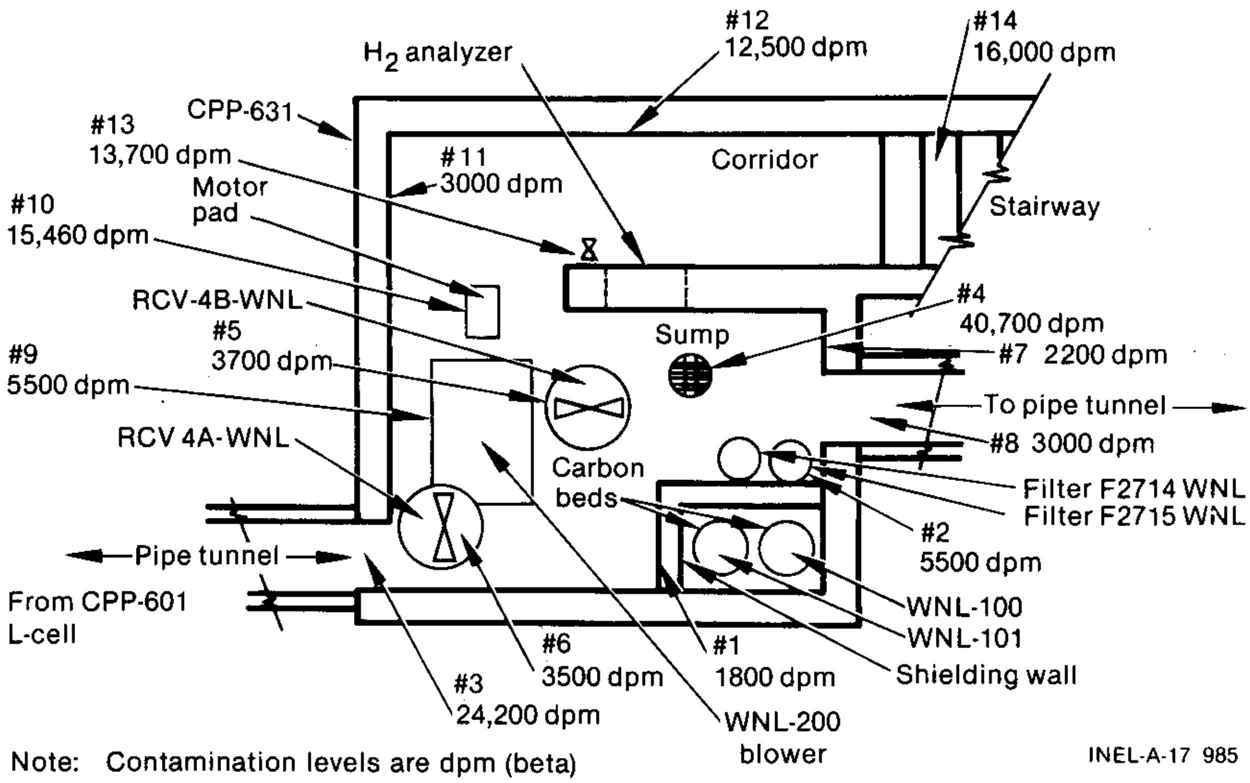


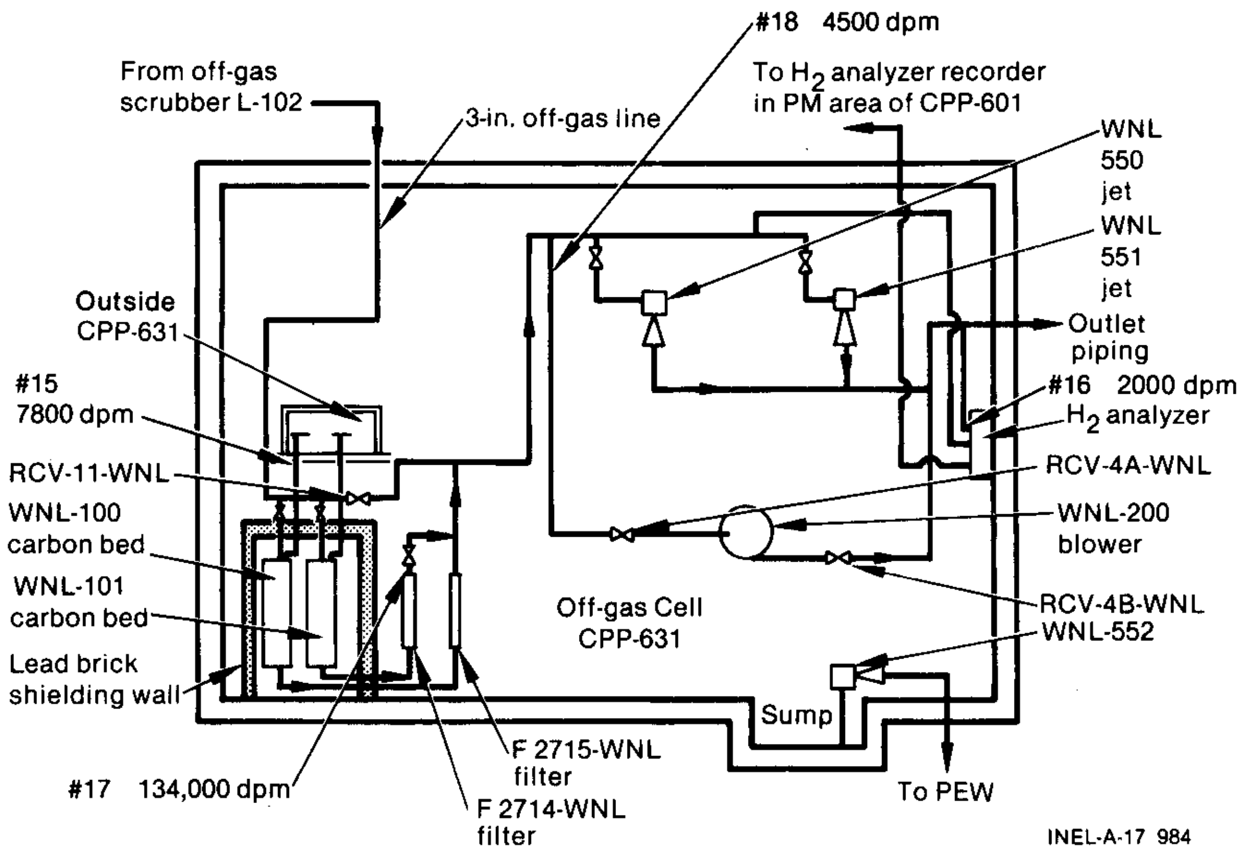
Figure 17. Simplified flow diagram showing fields inside piping.



Note: Contamination levels are dpm (beta)

All smears were standard smears (100 cm^2)
except smear no. 9 which was 200 cm^2

Figure 18. Location and contamination of smears.



Note: Smears were standard smears of 100 cm^2.

Figure 19. Simplified flow diagram showing location and contamination of smears inside piping.

TABLE 2. RADIOISOTOPES PRESENT IN RALA OFF-GAS CELL

Sample	Radioisotope and Activity
1. Smear from external surface of lead shielding wall	TRU:[a] <5 dps/sample Uranium: <0.5 μg/sample FP[b] (β, γ): 30 dps/sample Principal FP: ^{137}Cs
2. Smear from external surface of filter housing F-2715 WNL	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 92 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
3. Smear from external surface of 3 in. off-gas pipe at pipe tunnel from CPP-601	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 62 dps/sample Principal FP: ^{137}Cs, ^{90}Sr, ^{134}Cs
4. Smear from floor sump	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 683 dps/sample Principal FP: ^{137}Cs, ^{90}Sr, ^{134}Cs
5. Smear from external surface of valve RCV-4B WNL	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 400 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
6. Smear from external surface of valve RCV-4A WNL	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 58 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
7. Smear from west wall	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 37 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
8. Smear from external surface of 3-in. pipe at outlet pipe tunnel	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 50 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
9. Smear from external surface of blower WNL-200	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 91 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
10. Smear from floor at blower motor pad	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 208 dps/sample Principal FP: ^{137}Cs, ^{90}Sr

TABLE 2. (continued)

Sample	Radioisotope and Activity
11. Smear from west wall in corridor	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 208 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
12. Smear from north wall	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 208 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
13. Smear from external surface of H_2 analyzer sample return line valve located in corridor	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 228 dps/sample Principal FP: ^{137}Cs, ^{90}Sr, ^{134}Cs
14. Smear from bottom of stairway in access corridor	TRU: <5 dps/sample Uranium: analysis not performed FP (β, γ): 227 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
15. Smear from internal surface of carbon bed WNL-100	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 130 dps/sample Principal FP: ^{90}Sr, ^{137}Cs
16. Smear from internal surface of H_2 analyzer	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 33 dps/sample Principal FP: ^{137}Cs, ^{90}Sr
17. Smear from internal surface of filter F-2714 WNL	TRU: 62.8 dps/sample Uranium: 0.8 μg/sample FP (β, γ): 2317 dps/sample Principal FP: ^{90}Sr, ^{137}Cs, ^{125}Sb, ^{154}Eu
18. Smear from internal surface of off-gas line	TRU: <5 dps/sample Uranium: <0.5 μg/sample FP (β, γ): 75 dps/sample Principal FP: ^{137}Cs, ^{90}Sr

a. TRU is transuranic waste.

b. FP is fission products.

5. ESTIMATED WASTE WEIGHT AND VOLUME

The estimated weight and volume of the contaminated waste are shown in Table 3. The concrete waste included in this table assumes that the cell can be decontaminated by removing 1-in. from the interior surface of the cell.

The total volume in Table 3, 405 ft^3, is the unpackaged volume. Assuming a packaging density of 50%, the volume consumed in the RWMC will be 810 ft^3. If all the lead bricks and half the steel items can be smelted, the total volume (smelted and packaged) could be reduced to 452 ft^3.

TABLE 3. WASTE WEIGHT AND VOLUME ESTIMATES

Item	Material	Weight (lb)	Volume (ft^3)	Volume if Smelted[e] (ft^3)
Blower WNL-200	SS[a]	300	13	0.67
Carbon bed vessels WNL-100/101	SS	1,400[b]	14	3.1
Filter cases WNL F-2714/2715	SS	60[c]	0.4	0.13
Valves	SS	300	24	0.67
Jets	SS	20	0.3	0.04
H_2 analyzer	CS[d] case	30	3	0.07
Unit heater	CS	30	6	0.07
Cell piping	SS	3,000	224	6.67
Piping in tunnels	SS	2,100	12	4.67
Piping insulation	Asbestos	83	12	N/A
Support structure	CS	2,000	4	4.44
Shielding wall	Lead bricks	13,400	19	19.2
All interior surface	Concrete	8,900	59.3	N/A
Carbon beds	Carbon	200	14	N/A
Total		31,823	405	N/A

a. Stainless steel.

b. Without carbon bed.

c. Without removable filters.

d. Corrosion-resistant steel.

e. Assume an average density of 450 lb/ft^3 for steel and 700 lb/ft^3 for lead.

6. POTENTIAL PROBLEM AREAS

The steam piping in the tunnels and the cell are covered with asbestos insulation (Figure 5). The steam piping was used to heat the cell, operate the steam jet in the sump, and supply steam for required decontamination. Removal of this asbestos requires special procedures in order to avoid health hazards. These procedures will be specified in the D&D plan.

7. DRAWING LIST

1. CPP-D-1249, CPP RALA Off-Gas Storage Piping--CPP-631.

2. CPP-D-1321, CPP RALA Off-Gas Storage Pipe Tunnel Details.

3. CPP-E-1372, CPP RALA Off-Gas Blower Room, CPP-631 Plans and Elevations.

4. CPP-E-1373, CPP RALA Off-Gas Blower Room, CPP-631 Sections and Details.

5. CPP-D-1700, CPP RALA Off-Gas Storage Flowsheet.

6. CPP-D-1705, CPP RALA Off-Gas Carbon Bed Facility Piping Plan.

7. CPP-D-1706 and 1707, CPP RALA Off-Gas Carbon Bed Facility Piping Sections.

8. CPP-D-1709, RALA Off-Gas Carbon Bed Facility Structural Details.